NSW GOVERNMENT

Transport for NSW

Beaches Link and Gore Hill Freeway Connection

Appendix C

Environmental risk analysis

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Appendix C – Environmental risk analysis

An environmental risk analysis for the project has been carried out as part of this environmental impact statement. The following outlines the environmental risk analysis process and identifies the key environmental issues as determined by the analysis.

Assessment methodology

Identification of environmental risk categories

The environmental risk analysis process carried out for the project included:

- A preliminary environmental assessment (scoping report), that was carried out as part of the *State significant infrastructure application report* (Roads and Maritime Services, 2017) to allow early identification of the key environmental issues and to inform the State significant infrastructure application
- An assessment of the key issues identified in the Secretary's environmental assessment requirements for the project (refer to the Secretary's environmental assessment requirements checklist in Appendix A of this environmental impact statement)
- An environmental risk review carried out to confirm the impacts based on the results of the detailed investigations presented in this environmental impact statement.

Through the environmental risk analysis process, issues that may be associated with the project were identified and categorised as a 'key issue' or 'other' (see Table 1). This enabled the identification of any matters that might be considered as additional key issues and provided a basis for an appropriately detailed assessment of these additional key issues in this environmental assessment.

Table 1 Environmental risk analysis

Consequence level	Definition
Key issue	Potential for high or moderate impacts (actual or perceived) requiring further investigation to identify specific management and mitigation measures.
Other	Potential for low impacts that can be managed effectively with standard and/or best practice management and mitigation measures.

As required by the Secretary's environmental assessment requirements, this process of key issue identification and analysis continued during the course of preparing this environmental impact statement. Emphasis was placed on using the detailed information gathered for the project to identify and review potential environmental issues. More specifically, the analysis:

- Identified environmental issues, including key issues in the Secretary's environmental assessment requirements
- Examined potential impacts and proposed management and mitigation measures in relation to the identified issues
- Identified the impacts likely to remain after management and mitigation measures are applied (ie the residual impacts).

The identified environmental issues are described and assessed in Chapter 8 to Chapter 26 of this environmental impact statement. An assessment of cumulative impacts is presented in Chapter 27 (Cumulative impacts).

Likelihood and consequence analysis

To determine the residual impacts for each potential key issue, a risk analysis involving a likelihood and consequence analysis was carried out in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*.

This involved:

- Rating the risk of each identified potential impact by identifying the consequences of the impact and the likelihood of each impact occurring
- Considering the probable effectiveness of the proposed management and mitigation measures to determine the likely residual risk of each impact.

The definitions of the likelihood are provided in Table 2 and the definitions of consequences are provided in Table 3. The risk rating was then determined by combining the consequence and likelihood to identify the level of risk as shown in Table 4.

Table 2 Risk analysis likelihood definitions

Likelihood	Definition
Certain	Expected to happen routinely during the project life.
Likely	Could easily happen and has occurred on a previous similar project.
Unlikely	Possible, but not anticipated.

Table 3 Risk analysis consequence definition

Consequence level	Definition
Minor	• Minor effects on biological, social, economic or physical environment, built or natural • Minor short to medium term damage to small area of limited significance, easily rectified.
Moderate	• Moderate effects on biological, social, economic or physical environment, built or natural • Moderate short to medium term widespread impacts. More difficult to rectify.
Major	• Serious effects on biological, social, economic or environment, built or natural • Relatively widespread medium to long term impacts. Rectification difficult or impossible.

Table 4 Risk rating matrix

Likelihood	Consequence		
	Minor	Moderate	Major
Certain	Medium	High	High
Likely	Low	Medium	High
Unlikely	Low	Low	Medium

Environmental risk analysis

Using the framework described above, the environmental risk analysis for the project is presented in Table 5. The risk analysis identifies an initial risk rating for each of the environmental issues and the residual risk rating derived after the application of environmental management measures developed and recommended by this environmental impact statement (refer to Appendix Y (Compilation of environmental management measures)).

Table 5 Environmental risk analysis

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Traffic and transport								
Construction								
• Construction traffic impacts on road network performance • Local road and parking impacts.	Major	Certain	High	CTT1, CTT6, CTT7, CTT8, CTT9, CTT10, CTT11, CTT12, CTT13, CTT14	Minimising the movement of construction road traffic during peak periods and around construction support sites and the use of truck marshalling areas would reduce the likelihood and consequence of traffic impacts. Worker parking will be actively managed to minimise impacts on parking on local roads and may include provision of shuttle buses for workforce transport where appropriate. Additionally, road closures will occur outside of peak periods and/or during night time where feasible and reasonable, minimising impacts.	Moderate	Likely	Medium
• Temporary disruption to bus services • Construction impacts on cyclists and pedestrian routes	Major	Certain	High	CTT6, CTT7, CTT8, CTT9, CTT10, CTT12, CTT14, CTT15	Advanced notification of proposed transport network changes and restrictions along with directional signage and linemarking would reduce the consequence of impacts to public and active transport from the project.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Temporary maritime traffic impacts to recreational users, community groups and clubs, commercial and government operations.	Major	Certain	High	CTT2, CTT3, CTT4, CTT5, CTT7, CTT16	Consultation with relevant stakeholders, advance notification of maritime restrictions and the appropriate scheduling of construction marine traffic activities where feasible and reasonable would reduce the risk of maritime traffic impacts.	Moderate	Likely	Medium
Operation								
• Improved travel times and accessibility to and from the Northern Beaches • Road network performance improvements • Improved road safety • Provision of new and improved public and active transport links • Improved connectivity • Urban amenity improvements.	Positive impact.							

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Increased traffic on some parts of the arterial and local road network and changes to some access and parking arrangements	Moderate	Certain	High	OT1, OT2	Measures to reduce the increase of traffic on some parts of the arterial and local road network as a result of the project have been incorporated into the development of the project design (refer to Chapter 5 (Project description) of this environmental impact statement). Local area traffic management measures will be determined in consultation with relevant councils and implemented where feasible and reasonable to minimise the impact of the project on the surrounding local road network.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Noise and vibration								
Construction								
• Ground-borne noise impacts during tunneling.	Major	Likely	High	CNV1, CNV2, CNV7, CNV8	Measures to reduce ground-borne noise impacts during tunnelling have been incorporated into the construction methodology (refer to Chapter 6 (Construction work) of this environmental impact statement). The consequence of impacts would be reduced through periodic noise monitoring and evaluation of equipment performance where exceedances are recorded or predicted.	Moderate	Likely	Medium
• Airborne noise impacts from surface works during standard construction hours • Construction vibration impacts during standard construction hours.	Major	Certain	High	CNV1, CNV2, CNV5, CNV6, CNV7, CNV9, CNV10, CNV11	The selection and management of plant and equipment to minimise noise and vibration, detailed programming and respite protocols and the establishment of minimum buffer distances from vibration-generating activities as well as periodic noise monitoring would reduce the likelihood and consequence of potential impacts.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Noise and vibration impacts outside of standard construction hours from surface works.	Major	Certain	High	CNV1, CNV3, CNV4, CNV6, CNV8, CNV9, CNV10	The implementation of out of hours works protocols which specify noise controls such as programming the noisiest activities to occur during less sensitive time periods and the limiting of noise intensive work would reduce the likelihood and consequence of impacts.	Moderate	Likely	Medium
• Construction road traffic noise impacts.	Moderat e	Likely	Medium	CNV1, CNV4, CNV5, CNV6, CNV9, CNV10, CNV11	Minimising truck movements past sensitive receivers and during night-time periods would reduce the consequence of traffic noise impacts.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Reduced road traffic noise as a result of traffic moving off surface roads into the tunnels.	Positive impact.							
• Surface road traffic noise impacts.	Moderate	Certain	High	ONV1, ONV2, ONV3	Operational noise mitigation measures, including quieter pavements, traffic calming measures, noise barriers, at-property treatments or a combination of treatments as required have been incorporated into the development of the project design (refer to Chapter 5 (Project description) of this environmental impact statement) reducing the likelihood and consequence of impacts.	Minor	Likely	Low
• Noise impacts from motorway facilities (eg ventilation fans, attenuators, substations, fire water tanks, water treatment plant etc).	Moderate	Unlikely	Low	ONV4	The consequence of the impact of operational fixed facilities would be reduced as facilities will be designed to meet project specific noise criteria derived in accordance with the *Noise Policy for Industry* (NSW EPA, 2017a).	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Noise impacts from the new and improved open space and recreation facilities at Balgowlah.	Moderate	Certain	High	ONV5	The final design and layout of the new and improved open space and recreation facilities will be designed to meet intrusive noise criteria derived in accordance with the *Noise Guide for Local Government* (NSW EPA, 2013) where reasonable and feasible. The final layout will be subject to further noise assessment to confirm the need for and details of any additional noise attenuation required.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Air quality								
Construction								
• Local air quality impacts due to dust generation.	Major	Likely	High	AQ1, AQ3	The adoption of dust suppression management measures, including the use of water tanks and/ or carts, sprinklers, site exit controls (eg wheel washing systems and rumble grids), stabilisation of exposed areas and stockpiles, and surface treatments as part of the construction methodology for the project would minimise potential impacts.	Moderate	Likely	Medium
• Emissions from construction plant and equipment • Emissions during blasting (if required) • Odour impacts (if any) from treatment and stockpiling of dredged and excavated material.	Moderate	Likely	Medium	AQ1, AQ2, AQ4, AQ5, AQ6	The adoption of standard construction air quality mitigation measures would minimise the potential impacts from construction plant emissions, blasting (if required), and odour (if any) emanating from dredged and excavated material.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• In-tunnel air quality impacts to human health • Impacts to ambient air quality due to increased traffic and emissions from tunnel ventilation facilities • Odour impacts from vehicle emissions.	Moderate	Likely	Medium	Incorporated in project design (refer to Chapter 5 (Project description) and Chapter 12 (Air quality) of this environmental impact statement).	The tunnel ventilation system will be designed and operated to maintain in-tunnel air quality and to avoid portal emissions. Tunnel air will be discharged vertically via tunnel ventilation outlets to dilute and disperse emissions. Additionally, various operational measures are available to manage in-tunnel emissions and ambient air quality such as traffic management, cleaning the tunnel regularly, incident response and the provision of public information and advice. These measures would reduce the likelihood and consequence of impacts.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Human health								
Construction								
• Human health impacts associated with air quality.	Moderate	Likely	Medium	AQ1, AQ2, AQ4, AQ5, AQ6	The adoption of standard construction air quality mitigation measures would minimise the potential impacts from construction plant emissions, dust, blasting (if required), and odour (if any) emanating from dredged and excavated material and would reduce the likelihood of air quality impacts associated with the project.	Moderate	Unlikely	Low
• Human health impacts associated with noise and vibration from tunneling activities.	Moderate	Likely	Medium	CNV1, CNV2, CNV7, CNV8, CNV12	Measures to reduce ground-borne noise impacts during tunnelling have been incorporated into the construction methodology (refer to Chapter 6 (Construction work) of this environmental impact statement).	Moderate	Unlikely	Low
• Human health impacts associated with noise and vibration from surface works.	Major	Likely	High	CNV1, CNV2, CNV5, CNV6, CNV7, CNV9, CNV10, CNV11	The selection and management of plant and equipment to minimise noise and vibration, detailed programming and respite protocols and the establishment of minimum buffer distances from vibration-generating activities as well as periodic noise monitoring would reduce the likelihood of potential impacts.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Human health impacts associated with social impacts.	Moderate	Likely	Medium	SE2	Ongoing engagement will be carried out with representatives of user groups and managers of social infrastructure located near surface construction works/construction support sites and sensitive social infrastructure above the tunnel alignment reducing the consequence of impacts.	Minor	Likely	Low
• Underwater noise impacts (from piling and dredging activities) to human health.	Moderate	Likely	Medium	HH1, HH2	Monitoring of underwater noise during the early stages of piling activities will allow for the adaptation of management measures during construction of the project. Appropriate management measures will be implemented during impact piling. The monitoring results, management areas and proposed management measures will be peer-reviewed to ensure they adequately address potential health impacts. In addition, communication of the piling program to water-based recreational users will reduce the consequence of potential impacts.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Human health benefits associated with improved surface road air and noise environments, and social aspects across the broader network • Improvements to road safety with reduced traffic volumes along key road transport corridors, and new or upgraded pedestrian and cyclist infrastructure.	Positive impact.							

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Human health impacts associated with in-tunnel air quality • Human health impacts associated with ambient air quality.	Moderate	Likely	Medium	Incorporated in project design (refer to Chapter 5 (Project description) of this environmental impact statement).	The tunnel ventilation system will be designed and operated to maintain in-tunnel air quality and to avoid portal emissions. Tunnel air will be discharged vertically via tunnel ventilation outlets to dilute and disperse emissions. Additionally, various operational measures are available to manage in-tunnel emissions and ambient air quality such as traffic management, cleaning the tunnel regularly, incident response and the provision of public information and advice. These measures would reduce the likelihood and consequence of impacts.	Minor	Unlikely	Low
• Human health impacts associated with noise and vibration.	Moderate	Likely	Medium	ONV1, ONV2, ONV3	Operational noise mitigation measures, including quieter pavements, traffic calming measures, noise barriers, at-property treatments or a combination of treatments as required have been incorporated into the development of the project design (refer to Chapter 5 (Project description) of this environmental impact statement) reducing the likelihood and consequence of impacts.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Human health impacts associated with social impacts during operation.	Moderate	Unlikely	Low	SE1, LP5	Further design development will consider minimising the impact of the project on social infrastructure. Additionally, where parks, open space and sport and recreation areas are impacted by construction and not required for permanent infrastructure they will be reinstated and rehabilitated.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Non-Aboriginal heritage (construction stage only)								
Construction								
• Direct impacts to terrestrial heritage items, archaeology or heritage conservation areas • Direct impacts to maritime heritage items.	Major	Certain	High	NAH2, NAH3, NAH4, NAH5, NAH6, NAH7, NAH8, NAH9, NAH11, NAH12, NAH13, NAH14, NAH15	Through the implementation of standard heritage management measures and specific measures to manage the impact to individual heritage items, the consequence and likelihood of potential impacts would be reduced.	Moderate	Likely	Medium
• Potential direct impacts to terrestrial and maritime heritage items due to the proximity of construction vehicles and equipment.	Major	Unlikely	Medium	NAH3, NAH12, NAH14	Non-Aboriginal heritage awareness training to be provided for contractors prior to commencement of construction works will increase the understanding of potential heritage items and restricted zones implemented for some maritime heritage items that may be impacted during the project, reducing the likelihood of potential impacts.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Indirect impacts to terrestrial and maritime heritage items due to temporary visual, aesthetic and social impacts, or permanent settlement and vibration impacts • Indirect vibration, visual and settlement impacts to maritime heritage items.	Moderate	Likely	Medium	NAH1, NAH3, NAH4, NAH5 NAH6, NAH14, SG5, SG7, CNV7	Heritage interpretation will be incorporated into the urban design for the project reducing the consequence of potential indirect impacts to terrestrial heritage items. The establishment of minimum buffer distances from vibration generating activities and consideration of the heritage value of listed items will ensure adequate monitoring and management. Restricted zones will be implemented for some maritime heritage items along with additional pre-construction surveys and archival recording where required to manage indirect impacts to individual maritime heritage items.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Aboriginal heritage (construction stage only)								
Construction								
• Direct impacts to terrestrial Aboriginal heritage sites.	Major	Unlikely	Medium	AH5, AH6	Cultural and historic heritage awareness training will be carried out for personnel engaged in work that may impact heritage items, reducing the risk of impacting heritage items.	Moderate	Unlikely	Low
• Indirect impacts to terrestrial Aboriginal heritage sites due to vibration and settlement.	Moderate	Unlikely	Low	AH1, AH2, AH3, AH4	The consequence of impacts will be reduced through vibration monitoring to be carried out at AHIMS sites and the implementation of additional measures where exceedances are identified.	Minor	Unlikely	Low
• Direct and indirect impacts to potential submerged Aboriginal heritage sites.	Moderate	Likely	Medium	AH8, AH9	Specialist surveys prior to and during construction to determine whether soil units have the potential to contain cultural material and the recovery and documentation of any artefacts or cultural material will reduce the risk of potential impacts.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Geology, soils and groundwater								
Construction								
• Soil erosion and off site sedimentation during construction • Exposure of acid sulfate soils or soil salinity during construction.	Moderate	Likely	Medium	SG9, SG14, WQ15	The risk of potential impacts from soil erosion, off site sedimentation and acid sulfate soils will be reduced through the implementation of erosion and sediment measures at all work sites and surface road upgrades and testing for the presence of acid sulfate soils and subsequent management if required.	Minor	Unlikely	Low
• Disturbance of contaminated land or groundwater contamination during construction works • Marine contamination during dredging activities.	Major	Likely	High	SG8, SG10, SG11, SG12, SG13, SG15, SG17, SG18, SG19, SG20, WM3	Measures to reduce the disturbance of contaminated land or groundwater during construction including the investigation and management of potentially contaminated areas affected by the project will be incorporated into the construction methodology for the project. The discovery of previously unidentified contaminated material will be managed in accordance with relevant guidelines. Land disposal of marine sediments and any soil/fill material surplus to construction will be carried out in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014a).	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Disturbance of contaminated sediments during marine construction activities.	Major	Likely	High	SG17, WM3, WM4, WQ12, WQ16	The appropriateness of offshore disposal will be assessed in accordance with the *National Assessment Guidelines for Dredging* (Department of the Environment, Water, Heritage and the Arts, 2009). Marine sediments requiring disposal to landfill will be assessed in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014), reducing the consequence of potential impacts. Ongoing monitoring of dredge plumes, use of a backhoe dredge with a closed environmental clamshell bucket, operated within a localised floating silt curtain enclosure to dredge the top layer of marine sediment, and the appropriate transportation, storage and handling of dredged material would minimise impacts on marine water quality.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Groundwater drawdown impacts and tunnel inflows during construction • Impacts to groundwater quality due to saltwater intrusion, mobilisation of contaminants, or acidification during construction.	Moderate	Likely	Medium	SG1, SG2, SG3, SG6, SG16, SG18, SG19, SG20	The incorporation of measures to reduce groundwater inflows into tunnels will be applied as part of the construction methodology (refer to Chapter 6 (Construction work) of this environmental impact statement) as appropriate. Additionally, ongoing monitoring during construction will be carried out along with updates to groundwater modelling at different stages of the project allowing for the management of groundwater drawdown and any associated impacts. These measures would reduce the likelihood and consequence of impacts.	Minor	Unlikely	Low
• Ground movement (ie settlement) impacts to nearby buildings and structures.	Moderate	Likely	Low	SG4, SG5, SG7	The development of detailed predictive settlement models guiding tunnel design and construction will minimise settlement and would reduce the likelihood and consequence of potential impacts.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Ground movement (ie settlement) impacts to nearby buildings and structures.	Moderate	Likely	Low	SG4, SG5, SG7	The development of detailed predictive settlement models guiding tunnel design will minimise settlement and would reduce the likelihood and consequence of potential impacts.	Minor	Unlikely	Low
• Groundwater impacts due to tunnel inflows and drawdown • Impacts to groundwater quality due to saltwater intrusion, mobilisation of contaminants, or acidification during operation.	Moderate	Likely	Medium	SG1, SG2, SG3, SG16, SG18, SG19	Measures to reduce tunnel inflows and groundwater drawdown have been incorporated into the development of the project design (refer to Chapter 5 (Project description) of this environmental impact statement). Outcomes of updated groundwater modelling throughout construction will identify any requirements for further groundwater monitoring during operational phases.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Hydrodynamics and water quality								
Construction								
• Hydrodynamic impacts affecting tidal and current flows within Middle Harbour due to cofferdams • Marine water quality impacts from increased turbidity and sedimentation from dredging.	Major	Likely	High	WQ12, WQ16	The installation of silt curtains around dredge works will minimise impacts on marine water quality. Additionally, ongoing monitoring of dredge plumes will be carried out to validate the dredge plume dispersion predictions allowing for the implementation of additional management measures if exceedances occur. This will reduce the risk of potential marine water quality impacts.	Moderate	Unlikely	Low
• Surface water quality impacts due to soil disturbance, runoff and discharge of tunnel water.	Major	Likely	High	SG9, WQ10, WQ11, WQ14, WQ15	The implementation of erosion and sediment measures at all work sites and surface road upgrades, as well as construction wastewater treatment plants designed to treat wastewater generated during construction, would reduce the likelihood of impacts to surfaces water quality.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts on geomorphology, water availability and flows.	Major	Likely	High	WQ4, WQ8, WQ13, SG1, SG2, SG3, SG16, SG18, SG19	The construction drainage and discharge outlet infrastructure directing flows downstream to minimise alterations and erosion of watercourse bed and banks, along with the implementation of energy dissipation and erosion scour protection, would reduce the consequence of potential impacts to geomorphology, water availability and flows. Ongoing groundwater monitoring will inform the groundwater model as the project progresses, allowing for the implementation of management measures as required to manage any reduction in water availability and flow.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Operational hydrodynamic and water quality impacts within Middle Harbour due to tunnel.	Minor	Unlikely	Low	Incorporated in project design as described in Chapter 5 (Project description) of this environmental impact statement.	The immersed tube tunnel would result in the formation of a sill-like structure within Middle Harbour that may reduce water exchange and lead to low dissolved oxygen events at the near bed waters lasting slightly longer than currently occurs. However, vertical mixing within Middle Harbour occurs rapidly, hence the project is predicted to have a negligible effect on dissolved oxygen levels within Middle Harbour. Only minor hydrodynamic impacts to Middle Harbour are expected during operation of the project.	Minor	Unlikely	Low
• Surface water quality impacts due to runoff and discharge of tunnel water.	Moderate	Likely	Medium	SG16, WQ7, WQ17, WQ18	Wastewater generated from tunnel groundwater ingress and rainfall runoff in tunnel portals will be treated at a permanent wastewater treatment plant at the Gore Hill Freeway, reducing the likelihood of potential impacts.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts on geomorphology • Reduction in water availability and flows.	Moderate	Likely	Medium	WQ3, WQ4, WQ5, SG1, SG2, SG3, SG6, SG18	Consideration of water sensitive urban design during the development of the design for the stormwater management system and confirmation of the capacity of local stormwater systems to receive operation wastewater and the implementation of measures to control water outflow would reduce the likelihood of impacts on geomorphology. Ongoing groundwater monitoring will inform the groundwater model as the project progresses, allowing for the implementation of management measures as required to manage any reduction in water availability and flow.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Flooding								
Construction								
• Impacts on construction activities due to flooding.	Moderate	Likely	Medium	F3, F5, F6, F7, F8	Construction activities will be protected from impacts due to flooding by locating activities outside of flood prone areas, and/or the provision of local bunding and flood protection barriers as well as the adoption of a flood standard at tunnel entries.	Moderate	Unlikely	Low
• Impacts on flood-prone areas and properties.	Moderate	Likely	Medium	F5	The greatest potential for adverse impacts on flood behaviour in adjacent development is associated with Balgowlah Golf Course construction support site (BL10). The incorporation of measures aimed at mitigating the impact of the project on flood behaviour as part of the project design will reduce the likelihood of potential impacts during construction.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Flooding of the tunnels.	Moderate	Certain	High	F3 Incorporated in project design as described in Chapter 5 (Project description) of this environmental impact statement.	Implementation of flood emergency management measures as part of relevant environmental and/or safety management documentation during operation of the project will reduce the risk of impacts. The design of the project has incorporated flood walls and upgrades to existing stormwater drainage which will prevent the ingress of floodwater into the proposed tunnels for events up to the Probable Maximum Flood. The incorporation of measures aimed at mitigating the impact of the project on flood behaviour as part of the project design will reduce the likelihood of potential impacts during operation.	Moderate	Unlikely	Low
• Impacts on flood-prone areas and properties.	Major	Certain	High	F1, F2, F9, CC1	Consideration of future climate change and partial blockage of the local stormwater drainage system during further design development as well as the implementation of measures aimed at mitigating the impact of the project on flood behaviour will reduce the likelihood and consequence of potential impacts.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Biodiversity								
Construction								
• Impact on native vegetation, groundwater dependent ecosystems and threatened ecological communities.	Major	Likely	High	B1, B6, B10, B11, B12, B13, B15, B16, B25, B26, SG6	The implementation of exclusion zones, pre-clearing surveys, management of invasive species, minimisation of vegetation removal by the project, re-establishment of vegetation within the construction footprint where feasible and rehabilitation and restoration of habitats following construction would reduce the likelihood of impacts on vegetation and threatened ecological communities.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts to fauna habitat, including aquatic and marine habitats • Impacts on threatened fauna species and endangered populations.	Major	Likely	High	B1, B3, B4, B5, B6, B7, B8, B9, B10, B11, B12, B13, B14, B17, B18, B19, B20, B21, B22, B23, B24, B28, B29, B30, B31, B32, B33, B34, B37, B38	The implementation of pre-clearing surveys, species relocation, monitoring, adaptive management measures, stop work procedures, exclusion zones and the minimisation of vegetation removal by the project, re-establishment of vegetation within the construction footprint where feasible and rehabilitation and restoration of habitats following construction would reduce the consequence of impacts on fauna, endangered populations and fauna habitat. Preparation and implementation of a Large-eared Pied Bat activity-specific management measures that will include controls to manage high noise and vibration level activities and monitoring requirements. Development and implementation of adaptive management strategies to manage impacts on the Grey-headed Flying-fox.	Moderate	Likely	Medium
• Underwater noise impacts (from piling and dredging activities) to marine ecology.	Moderate	Likely	Medium	B5, B9, B37	Pre-construction surveys and visual monitoring from the harbour surface to identify any underwater noise related impacts on fish, a stop work procedure and the implementation of additional at	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
					source protection measures as required would reduce the risk of impacts.			

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• Impact on groundwater dependent ecosystems and threatened ecological communities.	Major	Likely	High	SG6, SG1, SG2, SG16	A focussed study will be carried out to confirm potential baseflow reductions at Burnt Bridge Creek, Flat Rock Creek and Quarry Creek due to groundwater drawdown, and whether this might have an increased effect on nearby groundwater dependent ecosystems. This will be carried out in conjunction with monitoring of groundwater levels, groundwater quality and surface water flows, as discussed in Chapter 16 (Geology, soils and groundwater) of this environmental impact statement. Where unacceptable ecological impacts are predicted, feasible and reasonable mitigation measures to address the impacts will be identified, incorporated into the detailed design, and implemented during construction. The mitigation measures considered will include tunnel linings. Measures will be implemented during tunnel construction to ensure that groundwater inflows during the operation phase do not exceed 1L/s/km on average over the entire tunnel length.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts to fauna habitat, including aquatic and marine habitats • Impacts on threatened fauna species and endangered populations.	Moderate	Likely	Medium	B2, B3, B4	The construction of connectivity measures such as fauna underpasses and rope crossing would facilitate the safe movement of fauna across the upgraded Wakehurst Parkway. Fauna exclusion fencing and the minimisation of impacts from artificial lighting constructed as part of the project would also reduce the likelihood of impacts.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Land use and property								
Construction								
• Property acquisition • Changes to lease arrangements.	Moderate	Certain	High	LP1, LP3	Acquisition of property as part of the project will be carried out in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, the *Roads and Maritime Services Land Acquisition Information Guide* (Roads and Maritime Services, 2014) and the NSW Government land acquisition reforms. Where acquisition is to occur the appointment of a Personal Manager – Acquisition will be available to answer questions and queries of property owners. The project has been designed to avoid impacts to private property where feasible. Consultation with landowners regarding changes to existing lease arrangements will reduce the consequence of impacts.	Minor	Certain	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Temporary land use changes and changes to access.	Moderate	Certain	High	LP2, LP4, LP5, LP6	Rehabilitation of land subject to temporary use by the project would reduce the consequence of impacts. Transport for NSW will maintain access to properties and moorings where feasible and/or develop alternative access arrangements in consultation with affected parties.	Moderate	Likely	Medium
Operation								
• Creation of subsurface stratum • Potential restrictions on future development due to subsurface tunnels and elevated receivers near operational ventilation facilities.	Minor	Certain	Medium	LP3, LP7	Where subsurface stratum acquisition is required, it would be carried out in accordance with *Fact sheet: Property acquisition of subsurface lands* (Roads and Maritime Services, 2015) and the land acquisition reforms announced by the NSW Government in 2016. Consultation with relevant councils regarding land use considerations applicable to future development in the immediate vicinity of ventilation outlets and management of any residual land remaining following construction of the project will reduce the likelihood of any potential impacts.	Minor	Certain	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Sterilisation of residual and surplus lands.	Moderate	Certain	High	LP2, LP4	Appropriate land use, taking into consideration the location, land use characteristics, area and adjacent land uses will be identified for any residual land remaining following construction of the project. These measures will reduce the risk of any potential impacts.	Minor	Unlikely	Low
Socio-economics								
Construction								
• Temporary impacts on social infrastructure and community values during construction • Impacts to businesses during construction (access, parking etc) • Access and connectivity impacts during construction	Moderate	Certain	High	SE1, SE2, SE3, BU1, BU2, BU3, LP4, LP5	Further design development will consider minimising the impact of the project on social infrastructure. Additionally, where parks, open space and sport and recreation areas are impacted by construction and not required for permanent infrastructure they will be reinstated and rehabilitated. Consultation will be carried out with businesses potentially impacted during construction. Consultation will aim to identify specific management measures for individual businesses, minimising the consequences of impacts.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts to business during construction, including passing trade, business visibility and demand for services.	Net benefit during construction.							
Operation								
• Improved access and connections, including provision of new and upgraded pedestrian and cyclist infrastructure • Reduced congestion and travel times • Provision of new and improved public open space and recreation facilities, addressing the under supply of sporting grounds available for public use, identified in the *Northern Beaches Sportsground Strategy* (Northern Beaches Council, 2017a).	Positive impact.							

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts to businesses during operation including employee and customer access, servicing and deliveries and displacement of businesses.	Moderate	Likely	Medium	BU1 and incorporated in project design as described in Chapter 5 (Project description) of this environmental impact statement.	Consultation will be carried out with businesses affected by property acquisition, or lease cessation, and the acquisition and compensation process will be implemented in line with the *Determination of compensation following the acquisition of a business guideline.* The development of the project design has ensured that impacts to businesses would be minimised. Businesses may also be positively impacted by increased passing trade and improved connectivity for customers and employees to some centres as a result of the project.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Landscape character and visual amenity								
Construction								
• Landscape character and visual impacts from construction activities and construction support sites.	Major	Certain	High	V2, V3, V4, V5, V6, V7, V8, V9, V10, V11, V12, V13	Development of construction support sites to minimise visual impacts for adjacent receivers, location of storage areas away from residential areas and use of neutral colours and designs for site hoardings would reduce the consequence of potential impacts to landscape character due to construction.	Moderate	Likely	Medium
Operation								
• Landscape character and visual impacts from surface infrastructure (tunnel portals, motorway facilities and ventilation outlets).	Major	Certain	High	V1, V9, V10, V12, V13	The preparation of an urban design and landscape plan implemented in line with the strategic urban design framework for the project, retaining and protecting existing trees adjacent to the works, trimming rather than removing trees and early planting works for operation phase screening buffers will reduce the consequence of potential impacts to landscape character due to the project.	Moderate	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Hazard and risk								
Construction								
• Transport and storage of hazardous substances and dangerous goods during construction.	Major	Unlikely	Medium	HR1, HR6	Transportation and storage of hazardous substances and dangerous goods in accordance with the relevant legislation, codes, guidelines and supplier's instructions will reduce the risk of any impacts.	Moderate	Unlikely	Low
• Ground movement (settlement) or geotechnical uncertainty causing damage to properties.	Major	Unlikely	Medium	SG4, SG5, SG7	The development of detailed predictive settlement models guiding tunnel design and construction and building condition surveying will minimise settlement and will reduce the consequence of potential impacts.	Moderate	Unlikely	Low
• Interactions between maritime traffic and tunnel construction equipment and infrastructure.	Major	Likely	Medium	CTT3, CTT4, CTT5, CTT16	Consultation with relevant stakeholders, advance notification of maritime restrictions and the appropriate scheduling of construction marine traffic activities will reduce the risk of maritime traffic impacts.	Moderate	Unlikely	Low
• Potential rupture of, or interference with, underground utilities.	Major	Unlikely	Medium	As outlined in Appendix D (Utilities management strategy)	The relocation of utilities as part of the project will be managed in accordance with Appendix D (Utilities management strategy) of this environmental impact statement.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Risk of bushfires.	Major	Unlikely	Medium	HR2, HR3, HR4, HR5	As part of construction, adequate access and egress for fire fighting vehicles and construction vehicles and staff will be provided, an emergency response plan and first response capabilities and adequate setbacks from bushfire prone vegetation near to the project will be implemented, reducing the risk of impacts.	Moderate	Unlikely	Low
Operation								
• Transport and storage of hazardous substances and dangerous goods during operation.	Major	Unlikely	Medium	HR6, HR10	The transport and storage of dangerous goods and hazardous substances will be prohibited through the mainline tunnels and on and off-ramp tunnels, reducing the risk of impacts.	Moderate	Unlikely	Low
• Traffic incidents, including incidents within the immersed tube tunnels.	Major	Unlikely	Medium	HR9, HR11	The tunnels have been designed to include fire and safety systems in accordance with international and Australian standards. Additionally, incidents within the tunnels will be managed in accordance with the memorandum of understanding between Transport for NSW and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services.	Moderate	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Risk of bushfires.	Major	Unlikely	Medium	HR7, HR8	The tunnel support facilities at the Wakehurst Parkway at Frenchs Forest and ventilation outlet at the Wakehurst Parkway at Killarney Heights will be designed with adequate access and egress for fire fighting vehicles and adequate setbacks from bushfire prone vegetation, reducing the consequence of impacts.	Moderate	Unlikely	Low
• Interference with aviation.	Major	Unlikely	Medium	HR12	Operation of ventilation outlets and motorway facilities will be in accordance with any conditions of approval, reducing the risk of impacts.	Moderat e	Unlikely	Low
Resource use and waste management								
Construction								
• Increased demand on electricity and water supply • Increased demand on local and regional resources including sand and aggregate • Increased diesel use during construction.	Moderate	Likely	Medium	WM1, WM2, WM5, WM6	The risk of potential impacts will be reduced by sourcing of construction materials for the project in accordance with the project's Sustainability Framework and with a preference for Australian materials and prefabricated products with low embodied energy. Opportunities for wastewater reuse and terrestrial spoil reuse will be investigated.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
• Impacts associated with poor waste management during construction • Impacts associated with unexpected waste volume or types.	Moderate	Likely	Medium	WM2, WM3, WM4, WM7, WM8, WM9	The implementation of the resource management hierarchy principles by the project, the classification of waste in accordance with relevant guidelines and appropriate transport, storage and handling of waste will reduce the likelihood and consequence of impacts.	Minor	Unlikely	Low
Operation								
• Increased electricity and water use during operation.	Moderate	Likely	Medium	WM10, WM12	Guided by the Sustainability Framework, the project will optimise resource efficiency and waste management during operation. The risk of potential impacts will also be reduced by the consideration of opportunities to reuse treated groundwater during project operation.	Minor	Unlikely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Sustainability								
An assessment of the sustainability of the project was carried out in Chapter 25 (Sustainability), which describes how sustainability principles have been applied to the design, construction and operation of the project including: • Application of the principles of ecologically sustainable development to the project • Legislation and policies relevant to the project • The Sustainability Framework that has been developed for the project, including the application of the Infrastructure Council of Australia's Infrastructure Sustainability rating scheme to the project. A Sustainability Management Plan for the project will be developed and implemented during detailed design, to give effect to the sustainability framework for the project. The Sustainability Management Plan will detail measures to meet the sustainability objectives and targets and Infrastructure Sustainability rating scheme credit requirements. With the proposed Sustainability Management Plan in place there is a low residual risk of the principles of ecologically sustainable development, relevant legislation and policies or the sustainability framework not being implemented across all elements of the project.								
Climate change risk and adaptation (operation stage only)								
• Impact of climate change on road operations and infrastructure • Impact of climate change on customer and staff comfort.	Major	Unlikely	Medium	CC1	During further design development flood modelling will continue to use sea level rise projections and rainfall projections, the extent of scour protection will be refined, sensitivity testing for drainage channels and culverts to future climate change will be carried out, increased capacity will be provided where feasible and reasonable, reducing the consequence of impacts.	Minor	Likely	Medium

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Greenhouse gases								
Construction								
• Emissions of greenhouse gases from embodied energy in construction materials and electricity consumption.	Moderate	Likely	Medium	GHG2	Implementation of the Sustainability Management Plan will ensure that greenhouse gas emissions produced by the project are minimised, reducing the consequence of impacts.	Minor	Likely	Low
Operation								
• Emissions of greenhouse gases from operational energy use and vehicle emissions.	Moderate	Likely	Medium	GHG1	Further design development will consider the implementation of energy efficient systems as part of the project where reasonable and practicable, reducing the risk of potential impacts.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Cumulative impacts								
Construction								
• Construction noise and traffic associated with developments in proximity to construction sites including the Western Harbour Tunnel and Warringah Freeway Upgrade project (if approved), the Chatswood to Sydenham component of Sydney Metro City & Southwest, and other developments.	Moderate	Likely	Medium	CNV1, CNV13, CI1, CI2	Coordination of work between project construction sites and construction works to avoid cumulative noise impacts and the incorporation of additional mitigation measures as required will be used to manage cumulative noise and traffic impacts.	Moderate	Likely	Medium
• Road based spoil haulage management (traffic and noise impacts).	Moderate	Certain	High	CNV13, CI1, CI2, CI5	Engagement within other nearby construction activities and coordination of haulage routes and road occupancy with other major transport projects via Greater Sydney Operations will reduce the risk of potential impacts.	Minor	Likely	Low

Potential impact	Initial risk rating (unmitigated)			Proposed environmental management measures	Effectiveness of key mitigation measures	Residual risk rating (with mitigation)		
	Unmitigated consequenc	Unmitigated likelihood	Unmitigated risk			Residual consequenc	Residual likelihood	Residual risk
Operation								
• When completed, the Western Harbour Tunnel and Beaches Link program of works is expected to deliver beneficial cumulative impacts including substantial increases in travel speeds through sections of the surface road network, improved reliability and connectivity and a reduction in average travel times.	Positive impact.							

Risk analysis outcomes

No potential impacts with a residual risk rating of ‘high’ were identified for the project.

A number of ‘medium’ level residual risks were identified. During further design development of the project, further review of the ‘medium’ residual risk level items would be carried out, and where necessary, additional refined environmental management measures would be developed to ensure that these risks are suitably mitigated. During further design development, opportunities would be identified for ‘medium’ level residual risks to:

- Resolve residual impacts and risks through further design refinement
- Develop suitable construction methodologies and carry out construction planning with the construction contractor to ensure that environmental management measures can be implemented effectively
- Implement a process of review, correction and audit for the management measures that were identified in this environmental impact statement and summarised in Appendix Y (Compilation of environmental management measures). This would be a process of continuous improvement that would form part of the construction environmental management plan and operational environmental management plan and would allow for environmental management measures to be updated or improved during the construction and operational phases, where practical.

Where ‘low’ level residual risks are identified, an appropriate process of continuous improvement would be applied to address these potential impacts during construction and operation as far as is reasonable and feasible.